

Table 13 Summary of congestion inference from the estimation of different network parameters

| Ref. | ML Technique | Network (location) | Dataset | Features | Output | Evaluation | |
|--------------------------|---|---|---|--|--|---|---|
| | | | | | | Settings | Results ^{ab} |
| El Khayat et al. [238] | Supervised: · MLP-NN · MART · Bagging DT · Extra-trees (offline) | Wired (end-system) | Synthetic data: · ns-2 simulation · > 1k random topologies Data distribution: · Training = 18k · Testing = 7.6k | · Packet size · RTT: avg, min, max, stdev · Session loss rate · Initial timeout · Packets ACK at once · Session duration · TLR | Prediction: · Throughput | Ensemble DT: · 25 trees NN: N/A | MSE (10^{-3}) ^c : · 0.245 · 0.423 · 0.501 · 0.525 |
| Mirza et al. [316] | Supervised: · SVR (offline) | Multi-path wired (end-system) | Synthetic data: · Laboratory testbed · Dumbbell multi-path topology · RON testbed | · Queuing delay · Packet loss · Throughput | Prediction: · Throughput | · 2 input features · RBF kernel | Rate of predictions with RPE $\leq 10\%$: · Lab: 51% · RON: 87% |
| Quer et al. [371] | Supervised: · BN (offline) | WLAN (access point) | Synthetic data: · ns-3 simulation · Star topology Data distribution: · Training = 40k · Testing = 10k | · MAC-TX · MAC-RTX · MAC contention window · CWND · CWND status · RTT · Throughput | Prediction: · Throughput | DAG: · 7 vertices · 6 edges | Using MAC-TX: · NRMSE = 0.37 Using all features: · NRMSE = 0.27 |
| Mezzavilla et al. [309] | Supervised: · BN (offline) | WANET (end-system) | Synthetic data: · ns-3 simulation · Topology: · (not mentioned) | · MAC-TX · MAC-RTX · Slots before TX · Queue TX packets · Missing entries in IP table | Classification: · Static · Mobile | DAG: · 6 vertices · 5 edges | Using MAC-TX and MAC-RTX: · Precision = 0.88 · Recall = 0.91 |
| Fixed-Share Experts [22] | Supervised: · WMA (online) | · WANET · Wired · Hybrid wired and wireless (end-system) | Synthetic data: · QualNet simulation · Topology: · Random WANET · Dumbbell wired Real data: · File transfer · Wired and WLAN | · RTT | Prediction: · RTT | · 1 input feature · 100 experts · Simple experts | MAE (ticks): · Synthetic data (ticks of 500ms): = 0.53 · Real data (ticks of 4ms): = 2.95 |
| SENSE [128] | Supervised: · WMA (online) | Hybrid wired and wireless (end-system) | Real data: · Dataset from [22] | · RTT | Prediction: · RTT | · 1 input feature · 100 experts · EWMA experts | MAE (ticks of 4ms): = 1.55 |
| ACCPndn [230] | Supervised: · TLFN · PSO · GA (online) | NDN (controller node) | Synthetic data: · ns-2 simulation · Topology: · DFN · SWITCH Data distribution: · Training = 70% · Validation = 15% · Testing = 15% | · PIT entries rate | Prediction: · PIT entries rate | · R input neurons · 2 hidden layers with R neurons · R output neurons R : number of contributing routers | MSE: · PSO-GA = 2.23 · GA-PSO = 3.25 · PSO = 4.05 · GA = 5.65 · BP = 7.27 |
| Smart-DTN-CC [412] | Reinforcement: · Q-learning · Boltzmann · WoLF (online) | DTN (node) | Synthetic data: · ONE simulation: · Random topology | States: · Input rate · Output rate · Buffer space Reward: · State transition | Decision-making: · Action to control the congestion (finite action-set: 12 actions) | · 3 input features · 4 states · 12 actions | Improvement to CCC: · Delivery ratio = 53% · Delay = 95% |

^aAverage values. Results vary according to the configured network parameters (e.g. topology, mobility, traffic)^bError metrics: MAE, MSE, NRMSE, and Relative Prediction Error (RPE)^cRespectively to the list of elements in the column ML technique